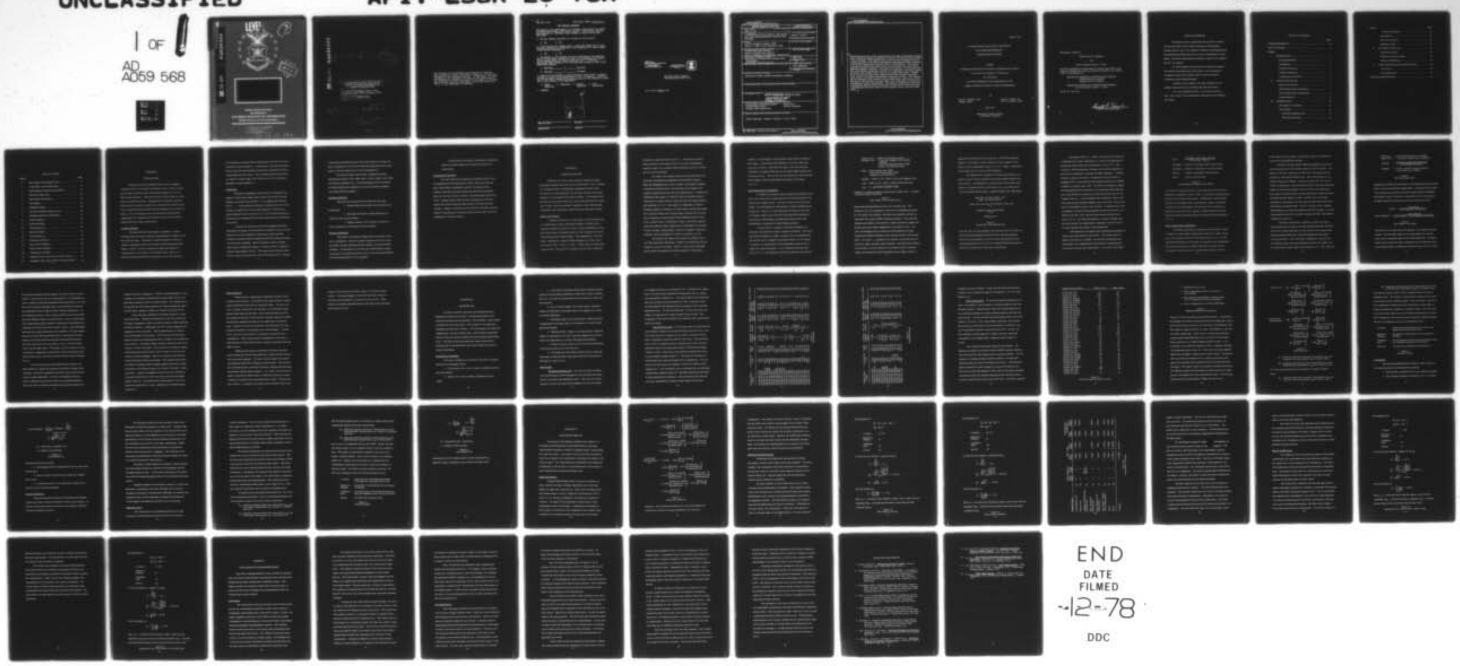
AD-A059 568 AIR FORCE INST OF TECH WRIGHT-PATTERSON AFB OHIO SCHO--ETC F/G 15/5
A COMPARATIVE ANALYSIS OF THE DEPOT AND BASE REQUIREMENTS COMPU--ETC(U)
JUN 78 P M NEEDHAM, A J OGAN

UNCLASSIFIED AFIT-LSSR-25-78A NL

1 OF 1
AD
A059 568



END
DATE
FILMED
-12-78
DDC

UNITED STATES AIR FORCE

AIR UNIVERSITY

AIR FORCE INSTITUTE OF TECHNOLOGY

Wright-Patterson Air Force Base, Ohio

(9) Master's thesis,

(6) A COMPARATIVE ANALYSIS OF THE
DEPOT AND BASE REQUIREMENTS
COMPUTATION SYSTEMS

(10) Paul M. Needham, Captain, USAF
Andrew J. Ogan, First Lieutenant, USAF

(14) AFIT - LSSR-25-78A

(11) Jun 78

(12) 64p

012 250 Gw

The contents of the document are technically accurate, and no sensitive items, detrimental ideas, or deliterious information are contained therein. Furthermore, the views expressed in the document are those of the author and do not necessarily reflect the views of the School of Systems and Logistics, the Air University, the United States Air Force, or the Department of Defense.

USAF SCN 75-20B AFIT Control Number LSSR 25-78A

AFIT RESEARCH ASSESSMENT

The purpose of this questionnaire is to determine the potential for current and future applications of AFIT thesis research. Please return completed questionnaires to: AFIT/SLGR (Thesis Feedback), Wright-Patterson AFB, Ohio 45433.

1. Did this research contribute to a current Air Force project?

   a. Yes b. No

2. Do you believe this research topic is significant enough that it would have been researched (or contracted) by your organization or another agency if AFIT had not researched it?

   a. Yes b. No

3. The benefits of AFIT research can often be expressed by the equivalent value that your agency received by virtue of AFIT performing the research. Can you estimate what this research would have cost if it had been accomplished under contract or if it had been done in-house in terms of manpower and/or dollars?

   a. Man-years ________ $ ________ (Contract).

   b. Man-years ________ $ ________ (In-house).

4. Often it is not possible to attach equivalent dollar values to research, although the results of the research may, in fact, be important. Whether or not you were able to establish an equivalent value for this research (3 above), what is your estimate of its significance?

   a. *Highly Significant* b. *Significant* c. Slightly Significant d. Of No Significance

5. Comments:

BY
DISTRIBUTION/AVAILABILITY CODES
A

________________________ ________________________
Name and Grade Position

________________________ ________________________
Organization Location

AFIT/LSGR
WRIGHT-PATTERSON AFB OH 45433

OFFICIAL BUSINESS
PENALTY FOR PRIVATE USE, $300

POSTAGE AND FEES PAID
DEPARTMENT OF THE AIR FORCE
DoD-318

AFIT/LSGR (Thesis Feedback)
Wright-Patterson AFB OH 45433

☆ U.S. Government Printing Office:1975-659-906
Region#5-11

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER LSSR 25-78A	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) A COMPARATIVE ANALYSIS OF THE DEPOT AND BASE REQUIREMENTS COMPUTATION SYSTEMS		5. TYPE OF REPORT & PERIOD COVERED Master's Thesis
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Paul M. Needham, Captain, USAF Andrew J. Ogan, First Lieutenant, USAF		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Graduate Education Division School of Systems and Logistics Air Force Institute of Technology, WPAFB OH		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS Department of Research and Administrative Management AFIT/LSGR, WPAFB OH 45433		12. REPORT DATE June 1978
		13. NUMBER OF PAGES 51
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS. (of this report) UNCLASSIFIED
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

APPROVED FOR PUBLIC RELEASE AFR 190-17.

JERRAL F. GUESS, CAPT, USAF
Director of Information

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Requirements Computation System
Variable Safety Level
Multiple Linear Regression
Stock Level
Mission Capability

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Thesis Chairman: Donald R. Edwards, Lt Col, USAF

DD FORM 1473, 1 JAN 73 — EDITION OF 1 NOV 65 IS OBSOLETE

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE(When Data Entered)

Determination of stock level requirements by the depot requirements computation system determines the quantity of assets to be procured and forwarded to base activities. Uncertainties exist at both the base and depot level concerning the ability of the depot requirements computation system to generate stock levels commensurate with the needs of base activities. The authors selected forty B-52 stock number items which exhibited recurring Mission Capability (MICAP) incidents. With these stock numbers, both the depot and base requirements computation systems were examined to determine whether the depot could compute levels necessary to support base needs. Multiple linear regression models were constructed for both systems using eight major factors of the depot requirements computation system. After examining the treatment of the variables in the multiple linear regression process, the authors concluded that the base repair cycle requirement variable was a driving factor in each of the models. The authors compared the actual base requirements against both the actual depot system and the model developed concluding that the depot system overall computes levels in excess of base needs.

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE(When Data Entered)

LSSR 25-78A

A COMPARATIVE ANALYSIS OF THE DEPOT AND BASE REQUIREMENTS COMPUTATION SYSTEMS

A Thesis

Presented to the Faculty of the School of Systems and Logistics

of the Air Force Institute of Technology

Air University

In Partial Fulfillment of the Requirements for the

Degree of Master of Science in Logistics Management

By

Paul M. Needham, BGS
Captain, USAF

Andrew J. Ogan, BS
First Lieutenant, USAF

June 1978

Approved for public release;
distribution unlimited

This thesis, written by

Captain Paul M. Needham

and

First Lieutenant Andrew J. Ogan

has been accepted by the undersigned on behalf of the faculty of the School of Systems and Logistics in partial fulfillment of the requirements for the degrees of

MASTER OF SCIENCE IN LOGISTICS MANAGEMENT
(INTERNATIONAL MAJOR)
(Captain Paul M. Needham)

MASTER OF SCIENCE IN LOGISTICS MANAGEMENT
(First Lieutenant Andrew J. Ogan)

DATE: 14 June 1978

Donald R Edwards
COMMITTEE CHAIRMAN

ACKNOWLEDGMENTS

The authors wish to acknowledge the assistance received from the personnel of the Logistics Operations Requirements Analysis Branch, Air Force Logistics Command in obtaining the data and technical information necessary for the accomplishment of this thesis. Particular appreciation is extended to Major Gary McMahon and Mr. Pat Morgan.

For their guidance and constructive criticism throughout the research and preparation of this thesis, we are indebted to Lieutenant Colonel Dale McKemey and our thesis chairman, Lieutenant Colonel Donald Edwards.

A special word of thanks is due Idava Needham for her patience and perseverance in dealing with this thesis team.

Last, but certainly not least, a very special thanks to Mrs. Joyce Clark for her professional contribution in the typing of this thesis.

TABLE OF CONTENTS

LIST OF FIGURES

CHAPTER I

INTRODUCTION

Among those assets managed by the Air Force Logistics Command (AFLC), three major areas must work in concert to insure that the base activities receive the necessary support to carry out their various missions. These three areas are the leveling, procurement, and repair processes. Although each is important, the leveling process is the initial activity which computes the quantities necessary to support the base activities and which impacts on the other two areas. It is the leveling process that determines the anticipated requirements for subsequent procurement actions as well as determining anticipated repair requirements.

Problem Statement

The depot and base requirements computation systems determine the stock levels at the base and the degree of support to the base from the depot. Through the continued interface of these two systems, appropriate levels for the bases are determined and maintained. However, several commands including the Strategic Air Command (SAC), the Tactical Air Command (TAC), and the Air Defense Command (ADCOM) have indicated to AFLC that bases are

not necessarily receiving assets commensurate with the stock levels computed at base activities (6). Furthermore, this same information indicates that the base and depot requirements computation systems compute different stock levels. The resulting problem is that bases are unable to acquire repair cycle assets from AFLC in sufficient quantities to meet demands (5).

Justification

The prime responsibility of the Air Force Logistics Command is to insure that combat units of the Air Force have the right supplies at the right time and place. To accomplish this mission, AFLC " . . . must maintain the ability to replenish base stock levels through a constant flow of recoverable material to and from our global deployed Air Force units [9:2-2]." It is in the best interest of the Air Force to manage the recoverable item inventory as efficiently as possible.

Leveling, the initial process toward managing the assets, determines the quantity to be purchased for support of base activities. Failure to correctly estimate the base needs creates shortage problems resulting in Mission Capability (MICAP) conditions throughout the various commands. MICAP conditions reflect shortages which affect or degrade the ability of a weapon system to respond to mission requirements (12:6-81). The repair process impacts similarly as repair projections flow from the leveling process. Because

of the serious problems that can result from improper leveling, the major commands as well as the Air Staff have appointed project managers to study the entire area of asset management (6).

The base and depot requirements computation systems determine the ability of the combat units to attract repair cycle assets in necessary quantities (2:6). An understanding of the two systems will help determine the significance of system interface problems concerning base level support.

Research Objectives

There are three objectives associated with this study:

1. Identify differences between base and depot computed levels.

2. Determine the effects of these differences in relation to base asset shortages.

3. Suggest changes to the systems to improve or resolve differences contributing to asset shortages.

Research Hypothesis

The impact of the depot leveling process on the base activities is tremendous. Failure to predict adequate levels may create both repair and procurement problems leading to increased MICAP incidents. To determine if in fact the depot requirements computation system is computing sufficient levels to meet base requirements, the following hypothesis will be examined:

A model based on the depot requirements computation system will reflect higher levels than actual base level requirements.

Organization of the Study

The first step toward satisfying the research objectives is the identification of the appropriate criteria used by the base and depot requirements computation systems to determine levels. Chapter II describes the basic background material and elements input into the depot and base systems to determine appropriate stock levels. Chapter III describes the basic methodology to be used to analyze the relative merit and effectiveness of the base and depot systems. Chapter IV details the actual analysis of the data collected. Chapter V presents the conclusions drawn from the study and recommendations for further research.

CHAPTER II

LITERATURE REVIEW

Within the Air Force, many inventory models have been developed to enhance the control of Air Force assets. Two of interest are the depot and base requirements computation systems which incorporate, at least implicitly, the carrying, shortage, and replenishment costs associated with inventory models. To facilitate future discussion of problems in this area, this section discusses the repair cycle system, base requirements computation, depot requirements computation, and the interface between the base and depot systems.

Repair Cycle System

A repair cycle asset is a serviceable or unserviceable item of a durable nature which, when unserviceable, normally can be repaired economically either by a base or depot maintenance activity. Each type of item is identified in the Air Force inventory by an individual National Stock Number (NSN). The expendability, recoverability, repairability, category (ERRC) designators for this type of item will be "XD1," "XD2," or "XF3." These items are high dollar valued assets. They tend to be complex in nature with components

available to repair the end item (10:11-1). With large amounts of funds invested in a few assets, the Air Force has established an extensive repair cycle system to insure adequate controls to protect the Air Force investment.

The repair cycle system includes both base and depot level activities concerning the management and movement of assets. Since the management and control of repair cycle assets is similar at both base and depot levels, the discussion of the repair cycle system in operation will deal with base activities only. At base level, maintenance and supply are required to take all prudent actions to obtain parts to repair items for which they have the repair authority and capability (11:17-2). Base supply is, additionally, tasked to maintain constant surveillance over these items to insure the speedy flow of unserviceable assets through supply channels and to prevent the accumulation of unserviceable assets pending receipt of tools, parts, technical data, or authority to repair. Base level responsibility rests with the chief of supply who is responsible for the issue, receipt, storage, requisitioning, release for shipment, inspection, inventory, and accountability for repair cycle items (11:17-3).

The intent of the repair cycle system is complete control over this large dollar investment. Repair cycle assets may only be issued on a one-for-one basis. That is, for each asset requested and received by maintenance (with the exception of initial issue

requests), a serviceable or unserviceable asset must be returned to base supply. Transactions from the depot to the base reflect this same type of control. Only after the repair cycle asset has been condemned or shipped off the base can the depot supply another asset to the base system. The one-for-one type transaction transcends the entire logistics system when dealing with repair cycle assets (11:17-3).

Base Requirements Computation

To obtain the necessary assets to support the mission of the base, stock levels and stockage policies have been developed for the standard base supply system. The basic formula used by the base (Figure 1) in determining the requirements is fairly straightforward in approach. However, to fully understand its impact on the base level supply system, this section will describe the development of stock levels, determination of appropriate demand levels, and determination of appropriate requisitioning quantities.

A stock level is a category to indicate the quantity of a particular item required on hand to support the mission. The stock level may be thought of as either a special level or a demand level. The special level is assigned by the depot because, for one reason or another, not enough items can be maintained in base stocks to support the mission demands. It is an artificially derived stock level (12:11-4). The demand level is the second type of stock level

Repair Cycle Demand Level = Repair Cycle Quantity (RCQ)
+ Order and Shipping Time Quantity (O&STQ)
+ NRTS/Condemned Quantity (NCQ)
+ Safety Level Quantity (SLQ)

RCQ = Daily Demand Rate (DDR)
x Percent of Base Repair (PBR)
x Repair Cycle Time (RCT)

O&STQ = DDR x (1.00 - PBR) x Order and Shipping Time

NCQ = DDR x (1.00 - PBR) x NRTS/Condemned Time

$$SLQ = C^{*} \sqrt{3 \times (RCQ + O\&STQ + NCQ)}$$

*Number of standard deviations authorized for safety stock. C equals 1 unless directed by HQ USAF.

Figure 1
Base Repair Cycle Demand Level

based upon past demands from users for a specific item. The demand level is the compilation of the order and shipping time quantity, the repair cycle quantity, the safety level quantity, and the not-repairable-this-station (NRTS)/condemned quantity. The order and shipping time quantity is the number of assets required to support the mission given the average shipping time from depot to base. The order and shipping time is computed by determining the average elapsed days between initiation of the order and receipt of the requisitions. The repair cycle quantity is the number of units that must be stocked to support the base repair program. The safety level quantity is the number of assets required to be on hand to insure continued support and operation during interruptions in the supply system or

unpredicted demands from base activities. The NRTS/condemned quantity is the number of items required to insure support in the event of NRTS/condemnation actions (12:11-4). Figure 1 illustrates the formulas used to arrive at these quantities.

The demand level computed by the base requirements computation system closely resembles the actual demands required by a base activity. An examination of one particular stock number item (Figure 2) indicated that the actual issues over a one-year period closely approximated the annual computed demand level requirement.

NSN 5865-00-039-5441EW XD2
Tuner TN 389A/ALR20A

Total Issues and Due-Out-Releases in One Year
34

Computed Annual Requirement
35.58

Demand Level
1

Figure 2
Actual Base Level Demand Data

Over the year, the total demands from the base were 35 in order to both fill the base demand level and meet all customer demands. Since the actual demands of 35 were closely approximated by the computed demand level of 35.58, the computed demand level will be used in all references to actual base requirements.

According to AFM 67-1, repair cycle levels will be tailored to individual base repair capabilities as a result of the application of the policies and procedures in being (Figure 1) (12:11-13). The criteria for determining when to assign a level and the quantities of the levels are important to the base and depot managers. A demand level for a repair cycle item is computed any time the number of demands is two or more and the daily demand frequency rate (DDFR) is equal to or greater than .0054. The DDFR is computed by adding the incremental parts of the number of the demands and dividing the sum by the difference between the current date and the date of first demand (Figure 3). A zero demand level is assigned a repair cycle item when the daily demand frequency rate is less than .0054 and the date of last demand is greater than 180 days. A demand level of one is assigned if the date of the last demand is less than 180 days, the DDFR is less than .0054, and the item previously qualified for a level (12:11-4). Once this determination to assign a demand level has been reached, the requirements computation formula (Figure 1) is used to indicate the quantity of the demand level.

Determination of the appropriate requisitioning quantities is based on the asset position at base level. The reorder level for repair cycle items is, normally, one less than the demand level. The quantity to be requisitioned is determined by subtracting the total assets from the total requirements. In the case of the repair

$$\text{DDFR} = \frac{\text{ND(2PSM)} = \text{ND(1PSM)} + \text{ND(CP)}}{\text{Current Date - DOFD}}$$

ND(2PSM) = Number of Demands 2nd Past Six Months

ND(1PSM) = Number of Demands 1st Past Six Months

ND(CP) = Number of Demands Current Period

DOFD = Date of First Demand

Figure 3
Daily Demand Frequency Rate (DDFR)

cycle items, all items physically on base that have not been clearly identified as condemned, ready to ship, or reported as redistributable material are counted as base assets. Demand data, which includes the date of first demand, date of last demand, number of demands, cumulative recurring demands, and the date of last releveling, is monitored by the base level computer to identify potential problem items and initiate appropriate follow-up actions with item managers (12:11-6).

Depot Requirements Computation

The depot requirements computation system (D041) is used to identify base and support requirements and to buy, repair, terminate, and/or dispose of assets at the depot level (10:1-1). To fully understand the impact of the system on repairable asset management, this section discusses the variable safety level concept, factors developed to determine levels, the actual determination of those

levels under the D041 system, and the depot support considerations toward base-generated requirements.

Recently, the D041 system underwent significant alterations with the introduction of the variable safety level (VSL) concept. The purpose of the VSL concept was to reduce the warehousing costs at the depot by reducing the safety levels. This reduction was accomplished throughout the depots. The basic design of the VSL concentrated on reducing the costs associated with procuring and maintaining assets by forcing the purchase of more of the low cost assets and fewer high cost assets thereby reducing the number of high cost items and improving the support to bases. Further, the VSL concept attempted to issue assets out to the base activities rather than allowing the depot to maintain them. The VSL concept is thus a management decision as to where the funds allocated will be spent. It is this concept under which AFLC currently manages the D041 requirements computation system (6).

The depot requirements computation system uses eight major input factors in order to develop the depot stockage objectives. The factor of initial importance to this system is the organizational and intermediate (OIM) base order and shipping time and repair cycle requirement. One of the major components to this factor is the OIM base repair rate which identifies the base level repair rate by subtracting out depot repair actions (Figure 4) (6). The order and

OIM Base Repair Rate = Total OIM Demand Rate (TOIMDR) - OIM Depot Demand Rate (OIMDDR)

$$\text{TOIMDR} = \frac{\text{Total Base Repairable Generations}}{\text{Past Installed Programs}}$$

OIMDDR = [(100% - NRTS %) x Base Condemn % + Base NRTS %] x TOIMDR

Figure 4
OIM Base Repair Rate

shipping time (O&ST) and base repair cycle quantities are determined based on the projected flying requirements. Computed with the repair cycle quantities are the base NRTS percentages and the condemned percentages (Figure 5) which are forwarded to AFLC from the base activities and input into the depot system on a quarterly basis.

$$\text{NRTS \%} = \frac{\text{Base NRTS}}{\text{Base Repairable Generations}}$$

$$\text{Base Condemn \%} = \frac{\text{Base Condemn}}{\text{Base Condemn + Base Repaired This Station}}$$

Figure 5
Base Repair Cycle Inputs

The O&ST is an average time in the pipeline to all supported organizations. The OIM depot repair cycle requirement is the second major factor considered under the level determinations. The depot repair rate as well as the depot condemned rate are figured into the overall requirements computations through the use of the AFLC data

base which accumulates the information over time for entry into the system. These factors tend to be manipulated to a certain degree in order to reflect current and anticipated flying requirements. According to AFLC the base and depot repair cycle information constitute the predominant factors within the depot leveling computations. Of the remaining six major factors, there are three more factors which deal with additional repair cycle information. Non job routed repair cycle requirements and the leadtime condemnation requirements are computed at the depot level and are based, in part, on the anticipated depot and base repair effectiveness and capability. The third repair factor is the base NRTS percentage which is reported in the same manner as the previously-discussed base determined information. The final three factors are the number of users, the procurement costs, and the repair costs. The number of users reflects all users worldwide as recognized by both the D041 system and the item manager who may remove any user from entry into the system computation (6).

Once the factors have been identified and computed, the D041 system can compute the required stock levels to support base activities. The actual computation of the D041 stock levels involves several complex algorithms. In order to determine the levels a series of programs must be processed in a preordained sequence since each relies on the data computed by the previous program (6).

Within this system computation, a "NRTS/condemned quantity" is not computed, but a pipeline requirement for depot repair time is computed with a maximum time of 120 days allotted. All computations of levels within the D041 make extensive use of past demand data which, on older items, extends to twenty-four months of past data (10:59).

One of the major objectives of the depot system is to minimize backorders. Through the introduction of the VSL concept into the depot computations, items are issued to bases to reduce potential backorder problems. Additionally, the VSL concept emphasizes the acquisition of low cost assets. This acquisition policy is used to reduce the quantity of base needs. AFLC makes use of the budget support objective in determining the level of support to be granted the base activities. The budget support objective represents what AFLC will pay to reduce backorders. This objective is selected by weapon system and special federal stock class to achieve a 92 percent fill rate for each item grouping. This is an average fill rate and may range dramatically within the grouping. The variable safety levels are used in conjunction with the budget support objectives to decide the number of incremental spares to be issued to the base to reduce backorders. Assets are shipped to the base until the reduction of backorders divided by the cost of the item is less than the budget support objective. The quantity and responsiveness of AFLC to a particular requisition is, in part, dependent on the budget support objective (3).

System Interface

Between the two requirements computation systems, there is little formal interface. The standard base supply system forwards repair information to the D041 on a quarterly basis. The base, however, receives no indication from the depot concerning depot repair actions which impact on the base. Other system interface involves the requisition process in which the base forwards requests for assets and the depot responds with what will be supported at a particular time. The base receives no information concerning the AFLC management decisions as to what assets will receive funding. Furthermore, there are no provisions to coordinate the respective level computations. Each system operates independently of the other in determining the levels and the amount of support required at base and depot level (6).

Additional information is gathered at both base and depot levels through the informal information flow between the base and the item and system managers. The base receives limited information concerning the likelihood of obtaining required assets. The information is limited because of the time involved in reaching and discussing the problems with the depot managers. As a result, such actions are usually reserved for MICAP items or those items that have created a number of problems over a prolonged space of time. This information, however, is valuable to the depot in that it informs them of the

urgency of the need and its mission impact at a particular base activity. The depot managers can take the necessary actions to increase asset availability to a particular base activity. These actions are manually generated based on the need of each individual base activity (12:6-81).

CHAPTER III

METHODOLOGY

In order to meet the objectives and ultimately test the hypothesis presented at the outset, a detailed description of the research processes will be discussed. The remainder of this chapter is divided into four major areas. The variables to be analyzed in subsequent sections will be defined. The study design will outline the sampling plan, the data collection plan, and the model development which provides the means to identify the base and depot model differences. The final two sections within this chapter deal with the methods used to evaluate and test the research objectives and the research hypothesis.

Description of Variables

The major variables are described at this point to enhance discussion in following sections:

1. Procurement Cost--Cost to obtain an additional asset by new procurement.

2. Repair Cost--Cost to obtain an additional asset by repair.

3. Lead Time Condemnation Requirement--Expected Organizational and Intermediate Maintenance (OIM) and overhaul condemnations over a period of time equivalent to that necessary to obtain new procurements.

4. Non Job Routed Repair Cycle Requirement--Expected number of repairables in the depot repair cycle pipeline as a result of overhaul operations.

5. OIM Depot Repair Cycle Requirement--Expected number of repairables in the depot repair cycle pipeline as a result of OIM generated demands.

6. OIM Base O&ST + Repair Cycle Requirement--Expected number of repairables in the base order and shipping time and base repair cycle pipelines as a result of OIM generated demands.

7. Number of Users--Sum of Air Force users with demand levels greater than zero for the past year.

8. Not Repairable This Station (NRTS) Percent--Expected percentage of OIM generated repairables which will be sent back to the depot for repair (4:2-4).

Study Design

Population Sampling Plan. The universe under consideration was the group of assets managed by AFLC that had been identified as recoverable and expendable assets. This area was further limited to include only those assets identified to AFLC as problem

B-52 support spares as of 31 December 1977. Problem B-52 support spares are those assets identified by Headquarters SAC as causing recurring MICAP conditions (5). The sample used for the subsequent tests was selected from this population by SAC in response to the excessive MICAP time experienced by a grouping of 40 recoverable, expendable items. Of the items identified, 25 were selected for the sample, through the use of random number tables (1:498). The remaining 15 were used to perform the validation of the models subsequently developed.

Data Collection Plan. The variables used to develop both the base and depot models were acquired through several sources. The AFLC data base which contains the raw data for the depot requirements computation system provided the basic data. Given this basic data, an AFLC computer program compiled the raw data and determined the values of the eight major factors of the selected sample (Figure 6) (4:20). The process was repeated to identify the factors for the validation sample (Figure 7). The levels for the base and depot models were acquired through AFLC computations. The raw data for the base levels was manually collected on request by SAC headquarters. This information was accumulated from the individual standard base supply accounts (5). The depot levels were developed through existing AFLC programs. AFLC personnel then made the necessary adjustments to equate the time frames of the levels

National Stock Number	Procurement Cost	Repair Cost	Leadtime Condemn Rqmt	Non Job Routed	OIM Depot Repair Rqmt	OIM Base O&ST Repr Cycle Rqmt	Users	NRTS
661500 086 7350	6963	572.13	6.534	.277	53.672	21.125	21	.39
661500 550 6628	1416	222.75	60.046	27.051	673.27	156.022	166	.90
662000 621 2903	314	142.26	43.206	12.774	62.439	14.838	16	.90
582100 371 4346AY	84147	1146	.875	0	4.874	9.054	16	.14
586500 431 9944EW	1504	300.80	4.665	.338	5.931	1.636	14	.88
586500 507 3031EW	49898	1210.85	0	2.25	16.061	21.114	17	.32
582100 186 6039	1900	78.95	0	.859	73.953	45.028	18	.90
128000 898 3679	7508	350.06	1.656	1.331	9.449	5.863	20	.89
582100 186 6309AY	7170	1439	0	0	12.665	22.929	17	.12
143000 184 4701NT	64161	3594	0	.256	30.644	8.512	15	.90
156000 605 9657FG	1061	797.9	0	0	0	0	9	.14
156000 605 9661FG	26065	3938.59	0	2.6	25.273	12.022	13	.29
156000 615 2534FG	31859	443.06	0	3.227	18.892	10.14	8	.18
165000 079 2295	32445	4363.77	8.856	1.138	7.539	3.742	12	.78
165000 143 8360	11031	1418	0	1.252	3.906	1.64	11	.88
166000 783 5884	1267	575.63	3.076	0	6.398	2.953	8	.83
166000 859 4008	3675	1713.25	11.856	.07	2.702	.926	6	.94
299500 891 0175	3449	1296	0	.3422	64.764	12.348	7	.93
128000 504 6061	385	127.92	0	26.208	86.459	46.568	21	.90
586500 937 4400	4404	69.51	0	.0867	5.369	31.977	22	.02
128000 250 1236	12558	452.94	0	0	3.383	5.418	15	.17
166000 195 2729	495.4	397.44	382.7	103.41	778.837	404.27	74	.90
166000 897 6848	6000	3250.16	3.767	.553	6.101	2.008	15	.86
660500 776 3234	10403	1462.18	7.442	0	96.328	18.889	21	.96
128000 167 5553	24752	878.95	5.775	0	32.139	11.657	15	.90

Figure 6
Test Sample

National Stock Number	Procurement Cost	Repair Cost	Leadtime Condemn Rqmt	Non Job Routed	OIM Depot Repair Rqmt	OIM Base O&ST Rpr Cycle Rqmt	Users	NRTS
661500 607 9408	3129	791.19	7.288	0	27.692	4.471	16	.90
586500 507 2967EW	60000	1459.91	0	12.5	15.318	9.592	18	.29
124000 471 5947	5187	844.14	0	.06	9.958	7.024	5	.71
128000 162 8143	1107	376.32	5.17	0	27.832	14.912	14	.90
431000 775 4693	2586	584.02	6.009	0	4.639	2.834	7	.59
432000 474 3550HS	2649	885.66	107.763	4.731	40.271	24.109	16	.89
432000 684 6070HS	3245	1168.71	18.961	3.237	22.492	10.286	16	.84
481000 116 4493HS	1617	343.99	15.869	.106	14.508	8.181	13	.92
660500 765 7180	19519	3479.46	0	.38	30.523	11.453	7	.94
660500 879 4529	1690	225.08	24.801	.183	30.267	8.385	20	.97
661000 101 0038	2514.52	210.84	4.361	1.086	6.605	3.203	15	.85
534000 718 0680FG	387.20	77.44	19.924	12.533	10.909	4.975	7	.50
163000 650 0788	208.40	203.27	93.15	2.215	42.416	15.621	47	.90
432000 065 7960	1524	304.80	1.911	0	1.059	.281	2	.84
128000 159 6185	33006	1523.85	0	0	14.485	12.586	16	.24

Figure 7
Validation Sample

computed by the two systems. In this case the levels were adjusted to reflect levels computed through the 30 September 1977 time frame (Figure 8) (5).

Model Development. To meet the objectives identified at the outset of this effort, it was necessary to develop models for the base and depot systems. Multiple linear regression analysis appeared to be an appropriate method by which to develop models of the base and depot systems. The two systems resemble multiple linear regression models in two ways. First, like multiple regression, the base and depot models use the values of several quantitative variables to predict the quantities required in future periods (8:529). Second, the base and depot systems appeared to support the basic underlying assumptions of the multiple linear regression model (Figure 9) (8:545).

Each model was developed using the same method. The Statistical Package for the Social Sciences (SPSS) computer program was used to perform the multiple linear regression analysis. For the purposes of meeting the initial research objective, the step-wise inclusion option was used in the regression process. The step-wise option established an entry sequence for each of the eight factors. The factors entered the equation in their order of decreasing marginal contribution toward the variation explained by the regression line to the total variation in the stock levels (7:345-347). The initial equations

National Stock Number	Depot Level	Base Level
661500 086 7350	51	58
661500 550 6628	964	436
662000 621 2903	192	39
582100 371 4346AY	26	17
586500 431 9944EW	26	6
586500 507 3031EW	39	25
582100 186 6039	246	60
128000 898 3679	6	16
143000 184 4701NT	20	27
156000 605 9657FG	0	1
156000 605 9661FG	19	25
156000 615 2534FG	9	21
165000 079 2295	8	29
165000 143 8360	20	15
166000 783 5884	24	7
166000 859 4008	3	6
299500 891 0175	69	20
128000 504 6061	265	63
586500 937 4400EW	172	52
128000 250 1236	34	16
166000 195 2729	1714	986
166000 897 6848	17	11
660500 776 3234	70	51
128000 167 5553	49	18
582100 186 6309AY	38	35
661500 607 9408	40	24
586500 507 2967EW	21	20
124000 471 5947	25	13
128000 162 8143	65	24
431000 775 4693	13	5
432000 474 3550HS	154	36
432000 684 6070HS	61	20
481000 116 4493HS	78	20
660500 765 7180	24	19
660500 879 4529	57	28
661000 101 0038	9	12
534000 718 0680FG	82	35
163000 650 0788	228	84
432000 065 7960	3	1
128000 159 6185	21	22

Figure 8
Test and Validation Sample Levels

1. Expected error is zero.

2. Error components in pairs of trials are uncorrelated.

3. Beta values are parameters, and the values of X are assumed to be known constants.

4. Error components are normally distributed.

Figure 9
Multiple Regression Assumptions

(Figure 10) were regressed using the SPSS program. A measure of the strength of the linear relationship between the eight major factors and the stock levels is given by the coefficient of determination (R^2). This measure ranges from zero, no linear relationship, to one, perfect linear relationship. An R^2 value of .80 generally indicates a strong enough relationship between the variables to use multiple linear regression as a model building technique (8:408). To be acceptable, each model was required to have a computed coefficient of determination greater than .80. Each model was then validated against the remaining 15 national stock number items. The process used to perform the validation was to compare the actual levels against the predicted levels generated from the models previously developed. The ability of each of the models to predict the levels of the validation sample was determined by performing the two-tailed paired t-test against the actual and predicted values. The following hypothesis test was developed to validate the base model:

$$\text{Depot Level} = \beta_0 + \beta_1\begin{pmatrix}\text{Procurement}\\ \text{Cost}\end{pmatrix} + \beta_2\begin{pmatrix}\text{Repair}\\ \text{Cost}\end{pmatrix}$$
$$+ \beta_3\begin{pmatrix}\text{Leadtime}\\ \text{Condemnation}\\ \text{Requirement}\end{pmatrix} + \beta_4\begin{pmatrix}\text{Non Job Routed}\\ \text{Repair Cycle}\\ \text{Requirement}\end{pmatrix}$$
$$+ \beta_5\begin{pmatrix}\text{OIM Depot}\\ \text{Repair Cycle}\\ \text{Requirement}\end{pmatrix} + \beta_6\begin{pmatrix}\text{OIM Base O\&ST}\\ \text{+ Repair Cycle}\\ \text{Requirement}\end{pmatrix}$$
$$+ \beta_7\begin{pmatrix}\text{Number of}\\ \text{Users}\end{pmatrix} + \beta_8\begin{pmatrix}\text{NRTS}\\ \text{Percent}\end{pmatrix}$$

$$\begin{matrix}\text{Actual Base}\\ \text{Requirements}\end{matrix} = \beta_0 + \beta_1\begin{pmatrix}\text{Procurement}\\ \text{Cost}\end{pmatrix} + \beta_2\begin{pmatrix}\text{Repair}\\ \text{Cost}\end{pmatrix}$$
$$+ \beta_3\begin{pmatrix}\text{Leadtime}\\ \text{Condemnation}\\ \text{Requirement}\end{pmatrix} + \beta_4\begin{pmatrix}\text{Non Job Routed}\\ \text{Repair Cycle}\\ \text{Requirement}\end{pmatrix}$$
$$+ \beta_5\begin{pmatrix}\text{OIM Depot}\\ \text{Repair Cycle}\\ \text{Requirement}\end{pmatrix} + \beta_6\begin{pmatrix}\text{OIM Base O\&ST}\\ \text{+ Repair Cycle}\\ \text{Requirement}\end{pmatrix}$$
$$+ \beta_7\begin{pmatrix}\text{Number of}\\ \text{Users}\end{pmatrix} + \beta_8\begin{pmatrix}\text{NRTS}\\ \text{Percent}\end{pmatrix}$$

Figure 10
Initial Equations

H_0: Difference between actual base requirements (μ_A) and predicted base requirements (μ_B) is equal to zero.

H_A: Difference between actual base requirements (μ_A) and predicted base requirements (μ_B) is not equal to zero.

The following hypothesis test was designed to validate the depot model:

H_0: Difference between actual depot requirements (μ_C) and predicted depot requirements (μ_D) is equal to zero.

H_A: Difference between actual depot requirements (μ_C) and predicted depot requirements (μ_D) is not equal to zero.

The rejection region (Figure 11) was computed using a 95 percent confidence level. The number of observations variable was the same as the number in the validation sample. The test statistic (Figure 12) was computed and compared with the t-distribution to determine its location in either the acceptance or rejection region. Since the object of the test in each model was to prove that the predicted levels did not differ statistically from the actual levels within the validation sample, the test was designed to prove the null hypothesis (H_0).

t-critical	taken from the t-distribution according to the degrees of freedom and α level.
degrees of freedom	the number of observations less one degree of freedom.
confidence level	for the purposes of the following hypothesis tests the confidence level will be 95 percent.
$\alpha/2$-level	one minus the confidence level divided by 2.

Figure 11
Rejection Region

Assumptions

The following assumptions were made in order to perform the required analysis of the information acquired:

1. The data base compiled by AFLC was valid and complete.
2. The computer programs developed by AFLC to compute

$$t_s \text{ (test statistic)} = \frac{\bar{d} - \mu}{S_d / \sqrt{n}} \qquad \bar{d} \text{ (mean)} = \frac{\sum_{i=1}^{n} di}{n}$$

$$S_d = \sqrt{\frac{\sum_{i=1}^{n} (di - \bar{d})^2}{n-1}}$$

di = actual rate - predicted rate

n = number of observations

Figure 12
Test Statistic (t_s)

variables and levels were valid.

3. Item managers did not significantly alter any data within the data base.

4. Base level data concerning asset usage was complete and accurate.

5. Leveling data did not vary materially through the buy point for each of the items examined.

Research Objectives

After the two sets of models were developed and validated, actions were taken to meet the objectives of this research effort. To that end, this section details the specific actions taken to fulfill the objectives originally set forth.

The differences between the base and depot models were determined through the examination of three areas. Using the stepwise inclusion option, the entry sequence of the various factors provides information as to the significance of each factor to the model. Examination of the R^2 values afforded additional information as to the contribution of each factor to the linear relationship. Finally, the beta values themselves provide information concerning the absolute values of the factors' weightings. The evaluation of the similarities and differences in the base and depot models was based on a subjective analysis of these factors.

The effects of these differences relating to asset shortages were determined through the evaluation of the hypothesis and the resulting hypothesis tests. A discussion of the effects of the differences and the resulting hypothesis tests will be presented in the next section.

Suggested changes to the systems to improve or resolve the differences contributing to the asset shortages were arrived at through the evaluation of the differences identified, the results of the hypothesis tests, and the information contained in the literature review chapter concerning the operation of the two systems.

Hypothesis Tests

The actual effects of the identified differences on base shortages were determined through several tests involving the

research hypothesis. The Air Force defines the effectiveness of depot support in measures of asset availability (3). As stated previously, it is the leveling process that ultimately determines the quantity to be procured for the base activities. Tests involving the depot and base levels will thus provide valuable information concerning the effectiveness of the depot requirements computation system toward supporting base activities.

The research hypothesis was tested using the paired t-test between the values of the depot system and the base system. This test was used in analyses involving the actual base and depot system values and the actual base and predicted depot values. The values referred to are the actual and predicted levels based on the model development. The paired t-test appeared appropriate as the intent was to test the effect of the change to the requirements computation formula given the actual requirements. This method provided a basis for comparing the effectiveness of the change (8:356). Each test used the t-distribution with a 95 percent confidence level.

To perform the actual paired observations test, four areas were examined and developed. First, the following hypothesis test was developed to analyze the actual system computations:

H_0: Difference between actual base requirements (μ_A) and actual depot requirements (μ_C) is equal to or greater than zero.

H_A: Difference between actual base requirements (μ_A) and actual depot requirements (μ_C) is less than zero.

The following hypothesis test was developed to compare depot model computations against actual base requirements:

H_0: Difference between actual base requirements (μ_A) and predicted depot requirements (μ_D) is equal to or greater than zero.

H_A: Difference between actual base requirements (μ_A) and predicted depot requirements (μ_D) is less than zero.

In each case, the hypothesis test was one-tailed. Second, the rejection region (Figure 13) was computed using a 95 percent confidence level. The number of observations variable is the same as the number of items sampled. Third, the test statistic was computed (Figure 14). Finally, the test statistic was compared with the t-distribution to determine its location in either the acceptance or rejection region. To achieve a strong statistical conclusion, the tests were designed to prove the alternate hypotheses (H_A).

t-critical	taken from the t-distribution according to the degrees of freedom and α level.
degrees of freedom	the number of observations less one degree of freedom.
confidence level	for the purposes of the following hypothesis tests the confidence level will be 95 percent.
α-level	one minus the confidence level.

Figure 13
Rejection Region

$$t_s = \frac{\bar{d} - \mu}{S_d/\sqrt{n}} \qquad \bar{d} = \frac{\sum_{i=1}^{n} di}{n}$$

$$S_d = \sqrt{\frac{\sum_{i=1}^{n} (di - \bar{d})^2}{n - 1}}$$

di = Actual Base Rate - Depot Rate

n = Number of Observations

Figure 14
Test Statistic (t_s)

Conclusions as to the relative merit of actual requirements as opposed to depot computations were derived from these tests.

CHAPTER IV

ANALYSIS OF RESULTS

The purpose of the analysis outlined in this chapter is to investigate and determine the overall effectiveness of the depot requirements computation system in computing support requirements for actual base needs. The results of the various tests discussed in the previous chapter will be presented to determine the validity of the research effort. The actual differences identified in the models will be examined as will the effects of those differences in the support of base requirements through the hypothesis tests.

Model Development

Using the SPSS multiple linear regression computer program, the base and depot leveling computations were regressed against the eight major input factors. Each of the resulting regression models (Figure 15) had a coefficient of determination (R^2) in excess of .99, thereby exceeding the .80 minimum acceptable R^2 criterion. The high R^2 value indicated an almost perfect linear relationship in each of the models. Following the development of these models, the factors for the remaining 15 stock number items contained in the validation sample were input into the developed

$$\underset{(Y)}{\text{Depot Level}} = -20.94115 - .00035\begin{pmatrix}\text{Procurement}\\ \text{Cost}\end{pmatrix}$$

$$-.00994\begin{pmatrix}\text{Repair}\\ \text{Cost}\end{pmatrix} + 0\begin{pmatrix}\text{Lead Time}\\ \text{Condemnation}\\ \text{Requirement}\end{pmatrix}$$

$$+2.78239\begin{pmatrix}\text{Non Job Routed}\\ \text{Repair Cycle}\\ \text{Requirement}\end{pmatrix} + .0859\begin{pmatrix}\text{OIM Depot}\\ \text{Repair Cycle}\\ \text{Requirement}\end{pmatrix}$$

$$+2.97502\begin{pmatrix}\text{OIM Base O\&ST}\\ \text{+ Repair Cycle}\\ \text{Requirement}\end{pmatrix} + 2.14582\begin{pmatrix}\text{Number}\\ \text{of Users}\end{pmatrix}$$

$$+32.78218\begin{pmatrix}\text{NRTS}\\ \text{Percent}\end{pmatrix}$$

$$\underset{(Y)}{\begin{matrix}\text{Actual Base}\\ \text{Requirements}\end{matrix}} = -5.93686 - .00003\begin{pmatrix}\text{Procurement}\\ \text{Cost}\end{pmatrix}$$

$$+.00081\begin{pmatrix}\text{Repair}\\ \text{Cost}\end{pmatrix} + .88173\begin{pmatrix}\text{Lead Time}\\ \text{Condemnation}\\ \text{Requirement}\end{pmatrix}$$

$$-.55233\begin{pmatrix}\text{Non Job Routed}\\ \text{Repair Cycle}\\ \text{Requirement}\end{pmatrix} + .14652\begin{pmatrix}\text{OIM Depot}\\ \text{Repair Cycle}\\ \text{Requirement}\end{pmatrix}$$

$$+1.38208\begin{pmatrix}\text{OIM Base O\&ST}\\ \text{+ Repair Cycle}\\ \text{Requirement}\end{pmatrix} + .58102\begin{pmatrix}\text{Number}\\ \text{of Users}\end{pmatrix}$$

$$-8.38344\begin{pmatrix}\text{NRTS}\\ \text{Percent}\end{pmatrix}$$

Figure 15
Regression Equations

equations. The resulting predicted levels were tested against the actual levels arrived at through independent AFLC and base

computations. The results of the tests (Figures 16 and 17) indicated that the models were valid for the grouping of stock number items selected by SAC. The statistical tests demonstrated that the predicted values from the two models did not differ statistically from the observed or actual values. Based on the coefficients of determination for the base and depot models and the subsequent validation effort, the models were demonstrated to be accurate for the subsequent tests involving the research objectives and hypothesis.

<u>Differences between Models</u>

To determine the differences between the two models developed, a series of three major areas were examined. The entry sequence, the contribution toward the coefficient of determination, and the beta values for each factor were compared between the two models (Figure 18). Both the similarities and the differences between the two models were examined.

The entry sequence of the variables into the two models revealed several similarities in treatment. Entry sequence refers to the order in which each variable entered the regression equation determined by each variable's decreasing marginal contribution to the explained variation. The base O&ST and repair cycle requirement was the initial entry into each of the models. Following was the depot repair cycle requirement. These two were believed by AFLC to strongly impact on the depot system. The entry sequence

The hypothesis is:

$$H_0: \mu_A - \mu_B = \mu_E = 0$$

$$H_A: \mu_E \neq 0$$

t-critical	$\pm$ 2.145
degrees of freedom	14
confidence level	.95
α-level	.05

To form the test statistic, compute $\bar{d}$ and S_d

$$\bar{d} = \frac{\sum_{i=1}^{15} di}{15} = 7.93$$

$$S_d^2 = \frac{\sum_{i=1}^{15} di^2 - \frac{\left[\sum_{i=1}^{15} di\right]^2}{n}}{n - 1} = 734.067$$

$$S_d = \sqrt{S_d^2} = 27.09$$

The test statistic is:

$$t_s = \frac{d - \mu_{do}}{S_d / \sqrt{n}} = 1.134$$

Since t_s = 1.134 falls in the acceptance region, fail to reject the null hypothesis (H_0). Conclude that the model values equal the base computed values.

Figure 16
Base Model Validation

The hypothesis is:

$$H_0: \mu_C - \mu_D = \mu_E = 0$$

$$H_A: \mu_E \neq 0$$

t-critical	± 2.145
degrees of freedom	14
confidence level	.95
α-level	.05

To form the test statistic, compute $\bar{d}$ and S_d

$$\bar{d} = \frac{\sum_{i=1}^{15} di}{15} = 1.53$$

$$S_d^2 = \frac{\sum_{i=1}^{15} di^2 - \frac{\left[\sum_{i=1}^{15} di\right]^2}{n}}{n-1} = 628.409$$

$$S_d = \sqrt{S_d^2} = 25.068$$

The test statistic is:

$$t_s = \frac{\bar{d} - \mu_{do}}{S_d / \sqrt{n}} = .236$$

Since $t_s = .236$ falls in the acceptance region, fail to reject the null hypothesis (H_0). Conclude that the model values equal the depot computed values.

Figure 17
Depot Model Validation

Variable Name		Entry Sequence Base Model	Entry Sequence Depot Model	Beta Value Base Model	Beta Value Depot Model	Contribution to R-Squared Base Model	Contribution to R-Squared Depot Model
Procurement Cost	X_1	8	7	-.00003	-.00035	.00001	.00030
Repair Cost	X_2	5	3	.00381	-.00994	.00047	.00203
Leadtime Condemnation Requirement	X_3	3	Not in equation	.88173		.00326	
Non-Job Routed Requirement	X_4	6	4	-.55233	2.78239	.00020	.00097
Depot Repair Cycle Requirement	X_5	2	2	.14652	.0859	.00437	,02218
Base O&ST + Repair Cycle Requirement	X_6	1	1	1.38208	2.97502	.98975	.96666
Users	X_7	4	5	.58102	2.14582	.00065	.00086
NRTS	X_8	7	6	-8.38344	32.78218	.00011	.00082
Constant				-5.93686	-20.94115		

Figure 18
Comparison of Models

tended to support that belief. The last two entries into the modes were also alike. The NRTS percentage and the procurement cost were entered as the last two values in each of the models. The middle factors differed as to entry sequence. An interesting exception was the exclusion of the leadtime condemnation requirement in the depot model.

The contribution toward the coefficients of determination for each model followed a pattern similar to the entry sequence. The entry of the base O&ST and repair cycle requirement, however, attained the necessary R^2 for acceptance of the model in accordance to the criteria specified in this effort. The entry of the depot repair cycle requirement elevated the coefficients of determination very close to the final figure. The remaining contributions to the models were not at all significant. The absolute figures differed between the two models. However, the degree to which each factor affected the model was shared between the two models developed.

The beta values for each of the factors were compared in treatment between the two models. The values differed quite substantially. The absolute comparison of the value of the betas between each model revealed no similarities. The impact of the values on the level determination revealed several similarities. The model constant always detracted from the level as did the procurement cost computation. The base O&ST and repair cycle requirement, depot

repair cycle requirement, and the number of users all had a positive impact on the level determination.

The results of the two tests indicated that the differences in the treatments afforded the factors in the base and depot models did not detract from the ability of the depot to support base activities. Overall, the substantial differences in the factor treatment did not contribute to the computation of lower levels that would have created potential shortage problems.

Effects of Differences

The validation of the two regression models allowed further consideration into the possible effects the differences between the two models have on the subsequent level computations. The effects of the differences previously identified and discussed are examined here. The purpose of this section is to determine any overall statistical differences in the levels computed by the depot and base systems and the depot model and base system.

The actual levels computed by the base and depot requirements computation systems were compared to determine the practical ability of the depot to generate adequate levels. The test and validation samples were consolidated for use in the test of the hypothesis. To achieve a strong statistical conclusion, the objective of the test was to prove the alternate hypothesis, that depot reflects higher levels than actual base level requirements. The results (Figure 19)

The hypothesis is:

$$H_0: \mu_A - \mu_C \geq 0$$

$$H_A: \mu_A - \mu_C < 0$$

t-critical	- 1.645
degrees of freedom	39
confidence level	.95
α-level	.05

To form the test statistic, compute $\bar{d}$ and S_d

$$\bar{d} = \frac{\sum_{i=1}^{40} di}{40} = -63.9$$

$$S_d^2 = \frac{\sum_{i=1}^{40} di^2 - \frac{\left[\sum_{i=1}^{40} di\right]}{n(40)}}{n - 1(39)} = 20754.5$$

$$S_d = \sqrt{S_d^2} = 144.06$$

The test statistic is:

$$t_s = \frac{\bar{d} - \mu_{do}}{S_d/\sqrt{n}} = -2.805$$

Since $t_s = -2.805$ falls in the rejection region, reject the null hypothesis (H_0). Accept the alternate hypothesis (H_A). Conclude that the depot levels are greater than the base levels.

Figure 19
Hypothesis Test, Base Actual vs Depot Actual

demonstrated that overall the depot actually computes levels greater than base requirements. The test statistic was well within the rejection region for the forty items considered.

The actual levels computed by the base and the predicted depot model levels were compared to determine the ability of the model that was developed to generate the necessary levels to support base requirements. Again, the test and validation samples were consolidated for use in the test of the research hypothesis. The results (Figure 20) again illustrated that the overall depot model computations were greater than the actual base requirements. The test statistic was well within the rejection region for the forty items considered.

The hypothesis is:

$$H_0: \mu_A - \mu_D \geq 0$$

$$H_A: \mu_A - \mu_D < 0$$

t-critical	- 1.645
degrees of freedom	39
confidence level	.95
α-level	.05

To form the statistic, compute $\bar{d}$ and S_d

$$\bar{d} = \frac{\sum_{i=1}^{40} di}{40} = -63.7$$

$$S_d^2 = \frac{\sum_{i=1}^{40} di^2 - \frac{\left[\sum_{i=1}^{40} di\right]}{n(40)}}{n - 1(39)} = 19568.26$$

$$S_d = \sqrt{S_d^2} = 139.88$$

The test statistic is:

$$t_s = \frac{\bar{d} - \mu_{do}}{S_d / \sqrt{n}} = -2.88$$

Since $t_s = -2.88$ falls in the rejection region, reject the null hypothesis (H_0) and accept the alternate hypothesis (H_A). Conclude that the predicted depot levels are greater than the base levels.

Figure 20
Hypothesis Test, Base Actual vs Predicted Depot

CHAPTER V

CONCLUSIONS AND RECOMMENDATIONS

This effort, although limited in scope, provides an introduction to the nature of the problems encountered by base activities when dealing with the depot requirements computation system. This chapter provides the framework within which conclusions may be drawn from the research findings and recommendations made concerning future research efforts.

Conclusions

The construction of the base and depot models demonstrated that the two requirements computation systems were conducive to examination using multiple linear regression concepts. Further, the models explained a great deal of the variance among the leveling computations by demonstrating an almost perfect linear relationship among the dependent and independent variables. The validation efforts verified the accuracy of the model toward predicting levels based on the eight D041 factors. The validity of the model should, however, have been based on a larger sample. The limiting factor to that end was the time constraints associated with this effort and the large amount of information required from numerous bases.

The models developed for each of the requirements computation systems exhibited several important similarities. The initial two entries for each of the models were the base O&ST and repair cycle requirement and the depot repair cycle requirement respectively. This tended to confirm the belief of AFLC personnel that repair cycle information impacts substantially on the leveling process. More specifically, the base order and shipping time and repair cycle requirement contributed most significantly to each of the leveling models. With the initial entry of that one requirement, the coefficient of determination in each model exceeded the .80 minimum R^2 criterion for use of the multiple linear regression modeling technique.

Although the beta values differed between models, the effects or impact of the differences on the ability of the depot system to meet user needs was the ultimate purpose of this effort. The problem facing a number of bases is a continuing shortage of required assets--assets for which the base is computing levels. The primary interest in this paper was to determine whether the depot was capably computing levels which meet base needs. The results of tests involving the actual and predicted depot levels against actual base requirements indicated that the depot was computing levels in excess of base requirements. Although the differences between base and depot models were quite significant in treatment of the eight major factors,

the differences indicated no negative impact on the ability of both the depot system and the depot model in predicting and computing levels to support actual base requirements.

These conclusions were significant when considering the sample used throughout this effort. The sample of items consisted exclusively of problem items for which the Strategic Air Command had experienced MICAP incidents over a prolonged period of time. When these assets were reported to AFLC, SAC believed AFLC to be neglecting to compute levels commensurate with the requirements of the using activities. In other words, the depot system was shown in this effort to be predicting adequate levels for base activities given the worst possible case.

Recommendations

One of the major problems at the base level is the acquisition of assets to support mission needs. Bases have long considered the leveling process as the source of the problem. There is no information currently provided the base activity or command function regarding the factors affecting the level determination or the manner in which a base factor affects level determination. The base activities should be made aware of the importance of the repair cycle information to the actual leveling process. Such information could reduce any inaccurate reporting of information which impacts on the D041 system. It would, also, provide an initial point of reference

for bases to examine when assets are difficult to acquire. An improved knowledge of the depot system by base activities might result in better utilization of the system.

Since the level computation does not appear to be the problem, actions should be taken by AFLC to examine where in the procurement and/or repair cycle areas the problems are being encountered which impact on the level of support rendered to base activities. To fully examine the repair problems, joint efforts should be conducted between AFLC and the using activities. This recommendation follows logically from the previous one advocating a larger share of the information to the base functions.

Several national stock number items examined in this effort maintained depot levels lower than base demands. Actions need to be taken by AFLC to provide some adjustment to the depot system to insure that demand levels computed by base activities are met by the D041 system. Depot levels should always equal or exceed the stated needs of the using activities. The AFLC data base receives the information necessary to determine the base requirements. Actions must be taken to draw this information out of the data base in a form that can be readily used by the item and system managers. It should be AFLC policy that depot levels have as a minimum parameter the aggregate base levels.

Future study into the base and depot requirements computation system should include an examination of non-problem as well as

problem items identified by SAC or AFLC as pertaining to the B-52 weapon system. A grouping of thirty stock number items within each area as well as a similar grouping for validation efforts would provide valuable information concerning the ability of the D041 to support levels required by bases. Expanding the study to include a cross-section of weapons systems across the Air Force would provide additional information concerning the possibility of computing levels using the multiple linear regression model as opposed to the complex D041 system.

Of similar interest is information concerning the actions that the variable safety level concept accomplishes in predicting levels. Further research into the actual methods behind the concept of the variable safety level would be most instructive to AFLC. Additional examination into the computations of the eight major factors coupled with the treatment of the factors within the multiple linear regression model will provide a basis for considering the variable safety level. Of additional interest is the number of levels in excess of requirements. Research into the variable safety level will shed some light into the methods causing the excessive levels.

Since the leveling process has been examined, future studies should begin to examine the procurement and repair areas which must work in concert with the leveling process in order to acquire the necessary support to the base activities. The procurement and repair

functions should be examined separately with the items considered within this study. Subsequent efforts should be broadened to include problem and non-problem items as well as other weapons systems representing a cross-section of the Air Force inventory.

Following the individual examination of the three areas of the AFLC asset management system, the relationships and interrelationships among the three areas should be examined. This study provided a cursory examination of the relationships at the outset of the effort. The manner in which the various areas impact on each other should be examined. Such research studies would be invaluable in determining the manner in which the Air Force Logistics Command utilizes the variable safety level concept in computing the levels and supporting the base activities.

The examination of the areas outlined above will provide a total examination and analysis of the depot requirements computation system (D041). Such information is badly required by AFLC in order to understand the D041 system currently in use. The piecemeal implementation of the various concepts into the requirements computation system resulted in a system that is not understood by the personnel who manage it. In depth analysis into the facets of the system complete with the interrelationships will be invaluable to AFLC.

SELECTED BIBLIOGRAPHY

1. Beyer, William H. Standard Mathematical Tables, 24th ed. Cleveland, Ohio: CRC Press, Inc., 1976.

2. Christensen, Bruce R., and Gene J. Schroeder. "A Comparative Analysis of the D041 System and Time Series Analysis Models for Forecasting Reparable Item Generations." Unpublished Master's Thesis. SLSR 27-76B, AFIT/SL, Wright-Patterson Air Force Base, Ohio, September 1976. ADA032364.

3. Clevenger, Anita. Inventory Management Specialist, Requirements Division, Deputy Chief of Staff for Materiel Management, Hq AFLC, Wright-Patterson Air Force Base, Ohio. Personal interviews. Conducted October 1977.

4. Hill, J. M. "Create Experimental Model, Computation of Stock Levels for Recoverable Items." Working Note Number 96, System Sciences Division, Directorate, Management Sciences, Hq AFLC, Wright-Patterson Air Force Base, Ohio, April 1977.

5. McMahon, Major Gary C. Materiel Requirements Analyst, Requirements Division, Deputy Chief of Staff for Materiel Management, Hq AFLC, Wright-Patterson Air Force Base, Ohio. Personal interviews. Conducted October 1977-May 1978.

6. Morgan, P. Inventory Management Specialist, Requirements Division, Deputy Chief of Staff for Materiel Management, Hq AFLC, Wright-Patterson Air Force Base, Ohio. Personal interview. Conducted October 1977.

7. Nie, Norman H., and others. Statistical Package for the Social Sciences, 2nd ed. New York: McGraw-Hill Book Company, Inc., 1975.

8. Patterson, James H., and Roger C. Pfaffenberger. Statistical Methods for Business and Economics. Homewood, Illinois: Richard D. Irwin, Inc., 1977.

9. U.S. Air Force Logistics Command. Management of Items Subject to Repair (MISTR). AFLCR 65-12. Wright-Patterson Air Force Base, Ohio: Hq AFLC, 1 July 1974.

10. ________. Recoverable Consumption Item Requirements System (D041). AFLCM 57-3. Wright-Patterson Air Force Base, Ohio: Hq AFLC, 25 September 1972.

11. U.S. Department of the Air Force. USAF Supply Manual. AFM 67-1, Vol II, Part One. Washington, D.C.: Government Printing Office, 1 January 1977.

12. ________. USAF Supply Manual. AFM 67-1, Vol II, Part Two, Washington, D.C.: Government Printing Office, 1 January 1977.